In [12]:
```
import numpy as np
import pandas as pd
```

In [13]:
```
import matplotlib.pyplot as plt
import seaborn as sns
```

In [14]:
```
from ipywidgets import interact
```

In [15]:
```
data = pd.read_csv('data.csv')
```

In [16]:
```
print("Shape of the dataset :", data.shape)
```

```
Shape of the dataset : (2200, 8)
```

In [17]:
```
data.head()
```

Out[17]:

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	82.002744	6.502985	202.935536	rice
1	85	58	41	21.770462	80.319644	7.038096	226.655537	rice
2	60	55	44	23.004459	82.320763	7.840207	263.964248	rice
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice
4	78	42	42	20.130175	81.604873	7.628473	262.717340	rice

In [18]:
```
data.isnull().sum()
```

Out[18]:
```
N              0
P              0
K              0
temperature    0
humidity       0
ph             0
rainfall       0
label          0
dtype: int64
```

In [19]:
```
data['label'].value_counts()
```

Out[19]:
```
rice           100
maize          100
jute           100
cotton         100
coconut        100
papaya         100
orange         100
apple          100
muskmelon      100
watermelon     100
grapes         100
mango          100
banana         100
pomegranate    100
lentil         100
blackgram      100
mungbean       100
mothbeans      100
pigeonpeas     100
kidneybeans    100
chickpea       100
coffee         100
Name: label, dtype: int64
```

In [20]:
```
print(" Average Ratio of Nitrogen in the Soil : {0:.2f}".format(data['N'].mean()))
print(" Average Ratio of Phosphorous in the Soil : {0:.2f}".format(data['P'].mean(
print(" Average Ratio of Potassium in the Soil : {0:.2f}".format(data['K'].mean()))
print(" Average Temperature in Celsius : {0:.2f}".format(data['temperature'].mean(
print(" Average Relative Humidity in % : {0:.2f}".format(data['humidity'].mean()))
print(" Average PH Value of the Soil : {0:.2f}".format(data['ph'].mean()))
print(" Average Rainfall in mm : {0:.2f}".format(data['rainfall'].mean()))
```

```
 Average Ratio of Nitrogen in the Soil : 50.55
 Average Ratio of Phosphorous in the Soil : 53.36
 Average Ratio of Potassium in the Soil : 48.15
 Average Temperature in Celsius : 25.62
 Average Relative Humidity in % : 71.48
 Average PH Value of the Soil : 6.47
 Average Rainfall in mm : 103.46
```

In [21]:
```
@interact
def summary(crops = list(data['label'].value_counts().index)):
    x = data[data['label'] == crops]
    print("............................................")
    print("Statistics for Nitrogen")
    print("Minimum Nitrogen required:", x['N'].min())
    print("Average Nitrogen required:", x['N'].mean())
    print("Maximum Nitrogen required:", x['N'].max())
    print("............................................")
    print("Statistics for Phosphorous")
    print("Minimum Phosphorous required:", x['P'].min())
    print("Average Phosphorous required:", x['P'].mean())
    print("Maximum Phosphorous required:", x['P'].max())
    print("............................................")
    print("Statistics for Pottasium")
    print("Minimum Pottasium required:", x['K'].min())
    print("Average Pottasium required:", x['K'].mean())
    print("Maximum Pottasium required:", x['K'].max())
    print("............................................")
    print("Statistics for Temperature")
    print("Minimum Temperature required: {0:.2f}".format(x['temperature'].min()))
    print("Average Temperature required: {0:.2f}".format(x['temperature'].mean()))
    print("Maximum Temperature required: {0:.2f}".format(x['temperature'].max()))
    print("............................................")
```

```
    print("Statistics for Humidity")
    print("Minimum Humidity required: {0:.2f}".format(x['humidity'].min()))
    print("Average Humidity required: {0:.2f}".format(x['humidity'].mean()))
    print("Maximum Humidity required: {0:.2f}".format(x['humidity'].max()))
    print("..........................................")
    print("Statistics for PH")
    print("Minimum PH required: {0:.2f}".format(x['ph'].min()))
    print("Average PH required: {0:.2f}".format(x['ph'].mean()))
    print("Maximum PH required: {0:.2f}".format(x['ph'].max()))
    print("..........................................")
    print("Statistics for Rainfall")
    print("Minimum Rainfall required: {0:.2f}".format(x['rainfall'].min()))
    print("Average Rainfall required: {0:.2f}".format(x['rainfall'].mean()))
    print("Maximum Rainfall required: {0:.2f}".format(x['rainfall'].max()))
```

interactive(children=(Dropdown(description='crops', options=('rice', 'maize', 'jute', 'cotton', 'coconut', 'pa…

In [22]:

```
@interact
def compare(conditions = ['N', 'P', 'K', 'temperature', 'ph', 'humidity', 'rainfal
    print("Average Value for", conditions, "is {0:.2f}".format(data[conditions].mea
    print("..........................................")
    print("Rice : {0:.2f}".format(data[(data['label'] == 'rice')][conditions].mean
    print("Black grams : {0:.2f}".format(data[(data['label'] == 'blackgram')][cond
    print("Banana : {0:.2f}".format(data[(data['label'] == 'banana')][conditions].
    print("Jute : {0:.2f}".format(data[(data['label'] == 'jute')][conditions].mean
    print("Coconut : {0:.2f}".format(data[(data['label'] == 'coconut')][conditions
    print("Apple : {0:.2f}".format(data[(data['label'] == 'apple')][conditions].mea
    print("Papaya : {0:.2f}".format(data[(data['label'] == 'papaya')][conditions].
    print("Muskmelon : {0:.2f}".format(data[(data['label'] == 'muskmelon')][condit
    print("Grapes : {0:.2f}".format(data[(data['label'] == 'grapes')][conditions].
    print("Watermelon : {0:.2f}".format(data[(data['label'] == 'watermelon')][cond
    print("Kidney Beans : {0:.2f}".format(data[(data['label'] == 'kidneybeans')][c
    print("Mung Beans : {0:.2f}".format(data[(data['label'] == 'mungbean')][condit
    print("Oranges : {0:.2f}".format(data[(data['label'] == 'orange')][conditions]
    print("Chick Peas : {0:.2f}".format(data[(data['label'] == 'chickpea')][condit
    print("Lentils : {0:.2f}".format(data[(data['label'] == 'lentil')][conditions]
    print("Cotton : {0:.2f}".format(data[(data['label'] == 'cotton')][conditions].
    print("Maize : {0:.2f}".format(data[(data['label'] == 'maize')][conditions].mea
    print("Moth Beans : {0:.2f}".format(data[(data['label'] == 'mothbeans')][condi
    print("Pigeon Peas : {0:.2f}".format(data[(data['label'] == 'pigeonpeas')][con
    print("Mango : {0:.2f}".format(data[(data['label'] == 'mango')][conditions].mea
    print("Pomegranate : {0:.2f}".format(data[(data['label'] == 'pomegranate')][co
    print("Coffee : {0:.2f}".format(data[(data['label'] == 'coffee')][conditions].
```

interactive(children=(Dropdown(description='conditions', options=('N', 'P', 'K', 'temperature', 'ph', 'humidit…

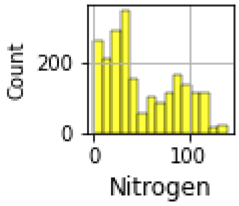
In [23]:

```
@interact
def compare(conditions = ['N', 'P', 'K', 'temperature', 'ph', 'humidity', 'rainfal
    print("Crops that require greater than average", conditions, '\n')
    print(data[data[conditions] > data[conditions].mean()]['label'].unique())
    print("..........................................")
    print("Crops that require less than average", conditions, '\n')
    print(data[data[conditions] <= data[conditions].mean()]['label'].unique())
```

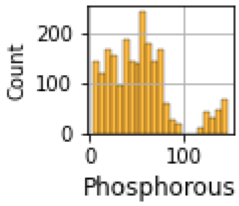
interactive(children=(Dropdown(description='conditions', options=('N', 'P', 'K', 'temperature', 'ph', 'humidit…

In [24]:

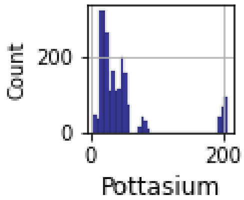
```
plt.subplot(3,4,1)
sns.histplot(data['N'], color="yellow")
plt.xlabel('Nitrogen', fontsize = 12)
plt.grid()
```



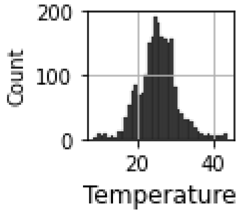
In [25]:
```
plt.subplot(3,4,2)
sns.histplot(data['P'], color="orange")
plt.xlabel('Phosphorous', fontsize = 12)
plt.grid()
```



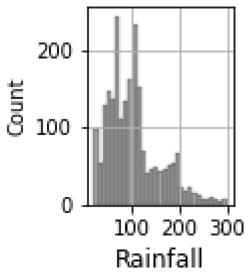
In [26]:
```
plt.subplot(3,4,3)
sns.histplot(data['K'], color="darkblue")
plt.xlabel('Pottasium', fontsize = 12)
plt.grid()
```



In [27]:
```
plt.subplot(3,4,4)
sns.histplot(data['temperature'], color="black")
plt.xlabel('Temperature', fontsize = 12)
plt.grid()
```

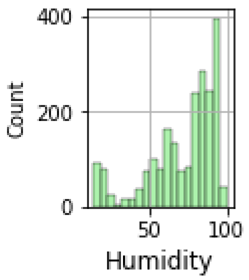


In [28]:
```
plt.subplot(2,4,5)
sns.histplot(data['rainfall'], color="grey")
plt.xlabel('Rainfall', fontsize = 12)
plt.grid()
```

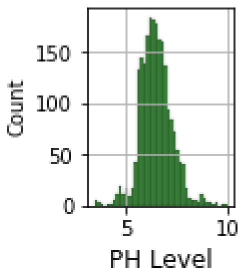


In [29]:
```
plt.subplot(2,4,6)
sns.histplot(data['humidity'], color="lightgreen")
```

```
plt.xlabel('Humidity', fontsize = 12)
plt.grid()
```



In [30]:
```
plt.subplot(2,4,7)
sns.histplot(data['ph'], color="darkgreen")
plt.xlabel('PH Level', fontsize = 12)
plt.grid()
```



In [31]:
```
plt.suptitle('Distribution for Agricultural Conditions', fontsize = 20)
plt.show()
```

```
<Figure size 432x288 with 0 Axes>
```

In [32]:
```
print("Some Interesting Patterns")
print("...........................................")
print("Crops that require very High Ratio of Nitrogen Content in Soil:", data[data
print("Crops that require very High Ratio of Phosphorous Content in Soil:", data[da
print("Crops that require very High Ratio of Potassium Content in Soil:", data[data
print("Crops that require very High Rainfall:", data[data['rainfall'] > 200]['label
print("Crops that require very Low Temperature:", data[data['temperature'] < 10]['
print("Crops that require very High Temperature:", data[data['temperature'] > 40][
print("Crops that require very Low Humidity:", data[data['humidity'] < 20]['label'
print("Crops that require very Low pH:", data[data['ph'] < 4]['label'].unique())
print("Crops that require very High pH:", data[data['ph'] > 9]['label'].unique())
```

```
Some Interesting Patterns
...........................................
Crops that require very High Ratio of Nitrogen Content in Soil: ['cotton']
Crops that require very High Ratio of Phosphorous Content in Soil: ['grapes' 'appl
e']
Crops that require very High Ratio of Potassium Content in Soil: ['grapes' 'appl
e']
Crops that require very High Rainfall: ['rice' 'papaya' 'coconut']
Crops that require very Low Temperature: ['grapes']
Crops that require very High Temperature: ['grapes' 'papaya']
Crops that require very Low Humidity: ['chickpea' 'kidneybeans']
Crops that require very Low pH: ['mothbeans']
Crops that require very High pH: ['mothbeans']
```

In [33]:
```
print("Summer Crops")
print(data[(data['temperature'] > 30) & (data['humidity'] > 50)]['label'].unique()
print("...........................................")
print("Winter Crops")
print(data[(data['temperature'] < 20) & (data['humidity'] > 30)]['label'].unique()
print("...........................................")
```

```
print("Monsoon Crops")
print(data[(data['rainfall'] > 200) & (data['humidity'] > 30)]['label'].unique())
```

```
Summer Crops
['pigeonpeas' 'mothbeans' 'blackgram' 'mango' 'grapes' 'orange' 'papaya']
...........................................
Winter Crops
['maize' 'pigeonpeas' 'lentil' 'pomegranate' 'grapes' 'orange']
...........................................
Monsoon Crops
['rice' 'papaya' 'coconut']
```

In [34]:
```
from sklearn.cluster import KMeans
```

In [35]:
```
x = data.drop(['label'], axis=1)
```

In [36]:
```
x = x.values
```

In [37]:
```
print(x.shape)
```

```
(2200, 7)
```

In [39]:
```
plt.rcParams['figure.figsize'] = (10,4)

wcss = []
for i in range(1,11):
    km = KMeans(n_clusters = i, init = 'k-means++', max_iter = 2000, n_init = 10, r
    km.fit(x)
    wcss.append(km.inertia_)
```

In [40]:
```
km = KMeans(n_clusters = 4, init = 'k-means++',  max_iter = 2000, n_init = 10, rand
y_means = km.fit_predict(x)
```

In [41]:
```
a = data['label']
y_means = pd.DataFrame(y_means)
z = pd.concat([y_means, a], axis = 1)
z = z.rename(columns = {0: 'cluster'})
```

In [42]:
```
#Checking the clusters for each crop
print("Lets Check the results after applying K Means Clustering Analysis \n")
print("Crops in First Cluster:", z[z['cluster'] == 0]['label'].unique())
print("...........................................")
print("Crops in Second Cluster:", z[z['cluster'] == 1]['label'].unique())
print("...........................................")
print("Crops in Third Cluster:", z[z['cluster'] == 2]['label'].unique())
print("...........................................")
print("Crops in Fourth Cluster:", z[z['cluster'] == 3]['label'].unique())
```

```
Lets Check the results after applying K Means Clustering Analysis

Crops in First Cluster: ['maize' 'chickpea' 'kidneybeans' 'pigeonpeas' 'mothbeans'
'mungbean'
 'blackgram' 'lentil' 'pomegranate' 'mango' 'orange' 'papaya' 'coconut']
...........................................
Crops in Second Cluster: ['maize' 'banana' 'watermelon' 'muskmelon' 'papaya' 'cott
on' 'coffee']
...........................................
Crops in Third Cluster: ['grapes' 'apple']
...........................................
Crops in Fourth Cluster: ['rice' 'pigeonpeas' 'papaya' 'coconut' 'jute' 'coffee']
```

In [43]:
```
#Splitting the Dataset for predictive modelling
```

```
y = data['label']
x = data.drop(['label'], axis=1)

print("Shape of x:", x.shape)
print("Shape of y:", y.shape)
```

```
Shape of x: (2200, 7)
Shape of y: (2200,)
```

In [44]:
```
#Creating training and testing sets for results validation
from sklearn.model_selection import train_test_split
```

In [45]:
```
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.2, random_s

print("The Shape Of x train:", x_train.shape)
print("The Shape Of x test:", x_test.shape)
print("The Shape Of y train:", y_train.shape)
print("The Shape Of y test:", y_test.shape)
```

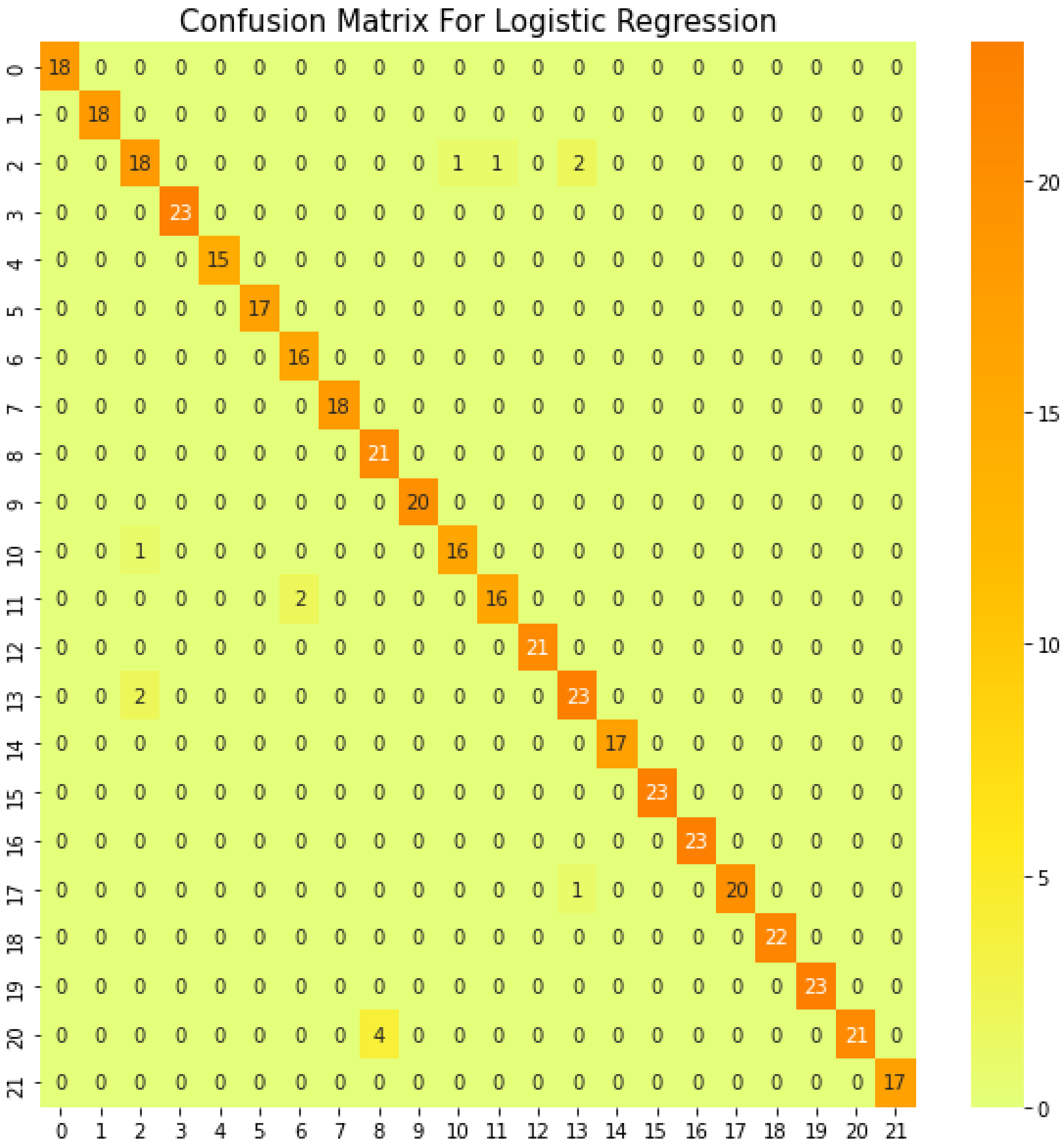
```
The Shape Of x train: (1760, 7)
The Shape Of x test: (440, 7)
The Shape Of y train: (1760,)
The Shape Of y test: (440,)
```

In [46]:
```
#Creating a Predictive Model

from sklearn.linear_model import LogisticRegression

model = LogisticRegression()
model.fit(x_train, y_train)
y_pred = model.predict(x_test)
```

```
c:\users\91953\appdata\local\programs\python\python39\lib\site-packages\sklearn\li
near_model\_logistic.py:444: ConvergenceWarning: lbfgs failed to converge (status=
1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
```

In [47]:
```
#Evaluating the model performance
from sklearn.metrics import confusion_matrix
```

In [48]:
```
#Printing the Confusing Matrix
plt.rcParams['figure.figsize'] = (10,10)
cm = confusion_matrix(y_test, y_pred)
sns.heatmap(cm, annot = True, cmap = 'Wistia')
plt.title('Confusion Matrix For Logistic Regression', fontsize = 15)
plt.show()
```



In [50]:
```
#Defining the classification Report
from sklearn.metrics import classification_report
```

In [51]:
```
#Printing the Classification Report
cr = classification_report(y_test, y_pred)
print(cr)
```

```
              precision    recall  f1-score   support

       apple       1.00      1.00      1.00        18
      banana       1.00      1.00      1.00        18
   blackgram       0.86      0.82      0.84        22
    chickpea       1.00      1.00      1.00        23
     coconut       1.00      1.00      1.00        15
      coffee       1.00      1.00      1.00        17
      cotton       0.89      1.00      0.94        16
      grapes       1.00      1.00      1.00        18
        jute       0.84      1.00      0.91        21
 kidneybeans       1.00      1.00      1.00        20
      lentil       0.94      0.94      0.94        17
       maize       0.94      0.89      0.91        18
       mango       1.00      1.00      1.00        21
   mothbeans       0.88      0.92      0.90        25
    mungbean       1.00      1.00      1.00        17
   muskmelon       1.00      1.00      1.00        23
      orange       1.00      1.00      1.00        23
      papaya       1.00      0.95      0.98        21
  pigeonpeas       1.00      1.00      1.00        22
 pomegranate       1.00      1.00      1.00        23
        rice       1.00      0.84      0.91        25
  watermelon       1.00      1.00      1.00        17

    accuracy                           0.97       440
   macro avg       0.97      0.97      0.97       440
weighted avg       0.97      0.97      0.97       440
```

In [52]:

```
#head of dataset
data.head()
```

Out[52]:

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	82.002744	6.502985	202.935536	rice
1	85	58	41	21.770462	80.319644	7.038096	226.655537	rice
2	60	55	44	23.004459	82.320763	7.840207	263.964248	rice
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice
4	78	42	42	20.130175	81.604873	7.628473	262.717340	rice

In [53]:

```
prediction = model.predict((np.array([[90, 40, 40, 20, 80, 7, 200]])))
print("The Suggested Crop for given climatic condition is :",prediction)
```

```
The Suggested Crop for given climatic condition is : ['rice']
c:\users\91953\appdata\local\programs\python\python39\lib\site-packages\sklearn\ba
se.py:450: UserWarning: X does not have valid feature names, but LogisticRegressio
n was fitted with feature names
  warnings.warn(
```

In [ ]: